employed in a discussion of the bearing of the electron theory on the problems of temperature radiation, magnetism, and the theory of metallic conduction. Finally, after an account of the theories of spectroscopic phenomena and the phenomena of radio-activity and X-rays, we are led into a discussion of the theories of the constitution of the atom.

It will be seen that the book covers a very extensive field. To give an adequate representation of the entire electron theory is naturally a task of the greatest difficulty, but the author appears to have done this in an admirable manner. Of necessity the treatment is at many points very restricted, but almost all points of general interest are considered. If any problem is treated more fully than others it is the theory of metallic conduction, as might naturally be expected from the author's own work. The exposition is throughout very clear and concise, and Prof. Richardson possesses a great gift of making even complicated arguments very easy for the reader to follow. A close connection with the latest experimental progress is everywhere maintained, and problems which involve hitherto unsolved difficulties are treated in a manner very far from being dogmatic.

In reading Prof. Richardson's book one gets ample opportunity to think about the present state of theoretical physics. The collection of the numerous brilliant achievements of the electromagnetic theory and the electron theory fills one with the greatest admiration. Still, the difficulties, first discovered with relation to the problem of temperature radiation and later in other problems, seem to be so great and of such a fundamental character that the theory will need very great alterations. Even if a way is indicated by Planck's theory no satisfactory solution of the difficulties has yet been found. In text-books only a few years old one finds great enthusiasm over what was called the future programme of the electromagnetic theory. It was believed that this theory constituted a final accomplishment of ordinary mechanics, and there appeared to be no limit to the application of the general principles of the theory. This attitude has changed most decisively. The impression obtained by reading the present book, however, is anything but merely disillusioning. Scarcely at any time has our knowledge increased so very rapidly as of late years, and, above all, we now possess much more powerful methods of experimental attack than were dreamed of a short time ago. Especially investigation of the radiation from radio-active bodies has proved most efficient in disclosing the internal structure of the atoms. If at present we may speak of a programme for the future development, it would, perhaps, be to examine the constitution of the special atomic systems actually existing, and then, by means of the directly observable properties of matter, possibly to deduce the general principles. If so, the evolution would be exactly the reverse of that anticipated.

In the present unsettled state, Prof. Richardson's book, which gives a balanced and masterly survey of a wide range of knowledge, will no doubt be especially welcome. It can be most heartily recommended, not only to students who seek an introduction to the electron theory, but to all interested in the modern development of physics.

N. B.

HORTICULTURE AND BOTANY.

(1) *The Standard Cyclopedia of Horticulture.* Vol. ii., C–E. By L. H. Bailey. Pp. 603–1200. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 25*s.* net.

(2) *Forage Plants and their Culture.* By C. V. Piper. Pp. xx+618. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 7*s.* 6*d.* net.

(3) *American Science Series. Essentials of College Botany.* By Prof. C. E. Bessey and Prof. E. A. Bessey. Pp. xiv+409. (New York: Henry Holt and Co., n.d.) Price 1.50 dollars.

(4) *The Story of Plant Life in the British Isles: Types of the Natural Orders.* Vol. ii. By A. R. Horwood. Pp. xiv+358. Vol. iii. Pp. xvi+514. (London: J. and A. Churchill, 1914.) Price 6*s.* 6*d.* net each.

(1) THE second volume of Bailey's "Cyclopedia of Horticulture" contains information on every subject pertaining to horticulture from "Cabbages" to "Extension Teaching in Horticulture," and is of a remarkably comprehensive character.

Every plant of interest the name of which lies between these two extremes is referred to; the derivation of the name is given, descriptive particulars of the plant, its geographical distribution, and notes on its method of cultivation go to make up each successive article. The book, though written primarily for the American horticulturist, contains much valuable information for extra-American countries. Certain articles, as that on the chestnut, remind one of the American origin of the work, as we are fortunate in being free from the dreaded chestnut fungus *Diaporthe parasitica,* which has caused such havoc in the United States. Diseases and insect pests receive extensive notice, and some forty double-column pages are taken up with descriptions of the various pests and the means of combating them. As with other articles, the text figures of fungi and insects are numerous and on the whole well-executed.

The genus Crataegus, which reaches so conspicuous a development in the States, has been carefully worked up by Prof. Sargent, and some nine hundred species are now recognised, to the confusion of European botanists and gardeners. In the encyclopædia the account of the genus occupies nearly eleven pages from the pen of Mr. Rehder, and the key to the fifty species which he mentions lends considerable value to the article. Eucalyptus again, another enormous genus but this time of introduced plants, occupies twelve pages, and there is a large illustration of a very fine specimen of *E. viminalis* growing in California. The key, which refers to as many as seventy-six species, is followed by short, useful descriptions with a few text-figures interspersed. Other large genera which fall within the compass of this volume are Cereus, Dendrobium, Echinocactus, Echinocereus, and Euphorbia, all of which receive very careful treatment.

There are a certain number of full-page illustrations, either in colour or in the form of photographic reproductions, which are well executed; among the latter that of cranberry-picking in a New Jersey bog makes a delightful picture; the coloured plates might have been dispensed with as they are of no particular interest. It is difficult to find any plant of importance or value which has been omitted. Owing to the large amount of material included, the volume is unduly bulky, and like other American publications suffers from its weight.

(2) "Forage Plants and their Culture" comes from the master-hand of the agrostologist in charge of forage-plant investigations of the United States Department of Agriculture, and is a valuable and well-illustrated agricultural handbook.

The introduction deals with forage crops generally, and in connection with the legumes an account of root nodules and nitrification is given. The chapters which follow treat of the preservation of forage and choice of crops, in which the results of feeding experiments, chemical analyses, the chemical composition as affected by the state of maturity of the crop, and other particulars are given.

The chapter on "Seeds and Seeding" is illustrated by useful plates showing the noxious weed seeds found among farm seeds. "Meadows and Pastures" and statistics of forage crops occupy the two next chapters. These are followed by detailed accounts of various crops, such as timothy, blue grasses, meadow grasses, the bromes, the sorghums, millets, and other grasses which figure prominently among the valuable forage plants of the United States. Among the legumes, alfalfa or lucerne occupies the first place, and the various clovers, peas, and vetches, soy beans, and other sub-tropical leguminous plants are discussed in some detail.

Root crops also come in for their share of attention. The book is written for the agriculturists of the United States, but the information it contains should prove of value to agricultural workers in South Africa, Australia, parts of northern India, and British East Africa, where many of the forage plants mentioned in the book can be successfully grown.

(3) A text-book which is said to contain only the essentials of the subject and written for "college teachers" may well be an uninteresting production, and that by Profs. C. E. and E. A. Bessey cannot be considered inspiring. It is to be hoped that the teachers who will use the book have already had their interest in botany roused and their enthusiasm for the subject fired by other teachers before taking up "the essentials" as a course of study. Not even the illustrations lend a helping hand, as they are singularly poor, and those of nuclear division are almost childish.

Though largely a very elementary treatise, the chapter on the chemistry of plants, with its masses of formulæ, is a formidable affair, and is too condensed to be of much practical value. The latter part of the book consists of a rapid classificatory survey of the vegetable kingdom with poor little figures. The book should not meet with much popularity on this side of the Atlantic.

(4) Mr. Horwood's second volume follows similar lines to the first one previously reviewed in NATURE. The introduction gives a rapid review of general botanical information which is not always sound; the statement on p. 8, for instance, that if the nucleus is damaged the plant dies, would suggest to the uninitiated that a plant possesses only a single nucleus. Other sweeping assertions, such as "the endodermis . . . is graviperceptional," that parasitic plants possess root-hairs, and that "the protection of the stomata from being clogged is ensured by the provision of hairs and their occurrence on the under-side of the leaf," may be received with caution by those who have a wider knowledge of botanical facts.

Mr. Horwood, after mentioning that "very little free nitrogen is obtained from the air by plants," proceeds to remark on the temperatures favourable to plant growth, and apparently without having made his calculations from Centigrade to Fahrenheit, states that the "most suitable temperature for plant growth is about 28° C., though plants can grow below this," and further, "above a temperature of 56° C. plants usually die." This latter statement corresponds fully with our own experience. For the rest, the book treats in detail of the Thalamifloræ, Calycifloræ, and certain Gamopetalæ; descriptions of the plants and their natural orders are given, and there are numerous illustrations reproduced from photographs.

The author states that "the facts of botany, like those of zoology . . . are capable of reduction to orderly arrangement," and it is to be regretted that he has not found himself able to follow out his opening text in the ordering of his material.

The third volume recently issued completes the work. There are 95 pages of introduction dealing with germination, plant formations, and many other unrelated subjects. These are followed by three chapters devoted to the Corollifloral and Apetalous Dicotyledons, and the Monocotyledons. There are numerous photographic illustrations.

MANUALS OF PHYSICS.

(1) *Practical Heat, Light, and Sound.* By T. Picton. Pp. xv + 151. (London: G. Bell and Sons, Ltd., 1915.) Price 1*s.* 6*d.*

(2) *Notes on Practical Physics for Junior Students.* By Prof. C. G. Barkla and Dr. G. A. Carse. (London: Gurney and Jackson, 1915.) Price 3*s.* 6*d.* net.

(3) *A Text-book of General Physics for College Students.* By Dr. J. A. Culler. (Philadelphia and London: J. B. Lippincott Co., 1914.) Price 7*s.* 6*d.* net.

(4) *Manuale di Fisica.* Vol. ii., Acustica, Termologia, Ottica. By Prof. B. Dessau. (Milan: Società Editrice Libraria, 1915.) Price 15 liras.

(1) SMALL school text-books frequently receive but scant attention from reviewers, but, when it is remembered that it is exactly in the earliest stages of a subject that students should be led to acquire those correct habits of thought and outlook without which real advance is impossible, we are not altogether persuaded that this attitude can be justified. It was with this in mind that Mr. Picton's book for the middle forms of schools was examined. An experimental exercise should have for its objects, first, the elucidation of physical principles, and secondly, should show how to conduct the measurements so as to obtain the best numerical result with the means at the disposal of the class. Most teachers will agree that the second of these is more easily secured than the first. As the preface puts it:—"A pupil may carry out conscientiously the written instructions, obtain a 'good result,' write a neat account, and yet have very indistinct ideas (and often no ideas at all) of the principles underlying the experiment." To overcome this mental inertia several questions are associated with each exercise, which must be answered before the student is allowed to proceed to the next experiment. The instructions are brief but sufficient, and can be thoroughly recommended for class-work. It may especially be noted that in the optical experiments a method is used which makes visible the paths of the rays—a considerable gain at this stage. The sections on concave lenses need revision, as the methods given are not the best available; also it would be a great advantage in future work if some use were made of books of tables, especially of reciprocals in lens experiments.

(2) Prof. Barkla and Dr. Carse's book is apparently a collection of some of the instructions used in the authors' laboratory at Edinburgh University. For the students there it will doubtless supply all that is required in the elementary classes, but beyond this it is not clear that it will fill any gap in the existing literature. As the directions are not written with reference to special forms of apparatus, they are available for the senior forms of schools. The first chapter on "Treatment of Observations and Determination of Error" is the best elementary discussion of the subject that we have seen.

(3) A comparison of English and American text-books of physics for colleges reveals a series of interesting differences. Taking them in order:—(1) American authors usually reduce the mathematical portions to a minimum; a rather unexpected feature if it be true that instruction in the States is so much more systematic than here, for in that case the usual excuse—that the student's mathematical knowledge is behind his physical requirements—should not be allowable. (2) More emphasis is placed on technical applications; a great advantage if the corresponding theory is developed. (3) There is a determination to be up to date as regards modern theories.

It is this last feature that is most strikingly in evidence in Dr. Culler's text-book. The author has set out to produce "a logical development of the live topics which, it seems, should be included in a text-book for college students," and, on the logical side, has not been altogether successful. To give two illustrations:—He desires to explain all the elementary electrical phenomena in terms of electrons, and finds it necessary to start the first paragraph with "What electricity is," followed on p. 3 with "Evidence for the electron theory," including a description of Thomson's experiments on kathode rays. Similarly, in the first page on magnetism we find ourselves immersed again in electrons. In each case terms have to be used which, at that stage, are incapable of